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ABSTRACT

The effects of low, full (normal) and high birthweights on the broad range of neonatal behaviors measured by the Brazelton Neonatal Assessment Scale were investigated in a study which also attempted to replicate results of the authors' earlier study of the Brazelton Scale. Data from the original sample of 52 infants were included in the later study to make a total sample of 140 clinically normal newborns of over 37 weeks' gestational age. The infants' behaviors were scored on the 27-item Brazelton Scale. The principal component factor analysis of the second study yielded three main factors: attention-orientation, arousal and temperament. Results for the attention-orientation factor showed a significant main effect for birthweight, in that the mean score for the full-weight or normal group was higher than that for either the low or high groups. With low-weight neonates rated as a high-risk group for later developmental problems, it is hypothesized that a similar potential may exist for high-weight infants of normal gestational age. There were also some sex-birthweight interactions for the arousal and temperament factors, but these data are given a cautious interpretation because of certain characteristics of the sample. (BF)

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Brazelton Scale Performance of Infants of Varying Birthweight[1]

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Several recent behavioral studies of the human neonate have used the Brazelton Neonatal Assessment Scale. The scale has been used in a variety of behavioral settings and represents an integration of many earlier behavioral assessment scales, in particular the Cambridge Newborn Scale (Brazelton & Freedman, 1971). The Brazelton Scale appears to be sensitive to several dimensions of neonatal behavior, namely, reflexive, attentional, and temperamental. When these dimensions are reflected during the examination of the newborn, the advantages of the scale become apparent. The advantages include in addition to its overall behavioral sensitivity, 1) an emphasis upon optimal performance during the examination, 2) a primarily behavioral thrust which is a departure from traditional neurological and developmental screening procedures, 3) the assessment of responses in several states of arousal.

The behavioral breath of the Brazelton Scale make it applicable for the assessment of clinically abnormal newborns as well as well infants from a variety of different cultural and racial backgrounds. Studies of traumatized newborns born to narcotic addicted mothers have shown the scale to be sensitive to the state of narcotic withdrawal in the newborn. Soule, Standley, Copans, and Davis (1974) found that the methadone babies' state of narcotic withdrawal was reflected by Brazelton scores. When compared with controls the methadone babies were in a more neurologically irritable condition. Strauss, Lessen-Firestone, Starr & Ostrea (1975) examined narcotically addicted infants in the first two days of life. They found that the addicted infants were less able to maintain alert states and less able to orient to auditory and visual stimuli than control infants. These deficits were especially

pronounced at 48 hours of age. Temperamental differences among newborns have also been reported using the scale. Freedman & Freedman (1969) found that Chinese-American and European-American newborns differ on a number of behavioral dimensions related to temperament.

In other studies, the Brazelton Scale has been found to be sensitive to the effects of obstetric medication on the behavior of the newborn. Standley, Soule, Copane & Duchowney (1974) examined three day old infants and found that the use of anesthesia appears to have a greater influence on the newborn than does analgesia. When the effects of analgesia were controlled, infants of mothers who had received anesthesia showed increased irritability and decreased motor maturity when compared with infants whose mothers had not received anesthesia. Additionally, Brazelton scores were not affected when levels of analgesia were compared with the effects of anesthesia controlled. Aleksandrowicz and Aleksandrowicz (1974) performed a factor analysis on the Brazelton Scale and found effects for obstetric medication on some selected items chosen to represent the factors. A follow-up study also found the scale to be superior to a traditional neurological examination in the percent of false positive predictions of suspect/abnormal 7-year olds (Tronick & Brazelton, 1975).

Whereas these studies have demonstrated the usefulness of the Brazelton Scale in identifying a number of behavioral dimensions, a major problem which remains is the extent to which these scale differences have been confounded with intervening variables not under investigation. For example, in the Strauss et. al. (1975) study disparities in gestational age between the experimental and control groups could have accounted for the observed differences. In fact Soule et. al. (1974) have argued

the likelihood of several variables acting interdependently to produce variations in performance on the Brazelton Scale. In a study by our research group the interdependence of high risk factors (mother's age, parity, birthweight, gestational age etc.) was illustrated in a multivariate study using the Brazelton Scale (Lester, Emory, Hoffman & Eitzman, 1976). Using the high risk factors as predictor variables in a stepwise multiple regression, birthweight of the newborn was found to be the best single predictor of items representing an attention-orientation factor. These results are in agreement with a study by Scarr and Williams (1971) in which items relating to an attention factor on the Cambridge Newborn Scale were found to differentiate low birthweight from full birthweight newborns.

Studies of the low birthweight and premature infant have found this group to be at risk for a number of later developmental problems (Birch & Gussow, 1970; Heiner et. al., 1968; Caputo & Mandell, 1970). These studies imply an inverse relationship between birthweight and later behavior in the population of newborns weighing less than 2500 grams at birth. Moreover, in postulating a deficit model of development, the human and comparative studies have focused upon the effects of such variables as low birthweight and malnutrition as representing a form of incomplete development to which some of these developmental anomolies can be attributed. Results obtained from the study of the "small" newborn could lead, in some respects, to a somewhat myopic view of what constitutes deviant or high risk birthweight status.

Whereas the effects of low birthweight have been investigated, virtually no attention has been given to the newborn of high birthweight

status. From a pediatric perspective however Vaughan and McKay (1975) have pointed out that newborns of high birthweight status are also at risk and have increased mortality rates as well as other physiological difficulties associated with their birthweight. Prenatal variables which show a significant correlation with high birthweight are not clearly defined. Although there is an increased incidence of maternal diabetes in this group, the behavioral consequences of high birthweight remain virtually unknown.

The purpose of the present study is two fold. First it is an attempt to replicate the results of our previous study of the Brazelton Scale (Lester et. al., 1976) by examining the stability and reliability of the factors previously reported. The second aspect of this study is to investigate the effects of varying birthweight status on the broad range of behaviors assessed by the Brazelton Scale during the neonatal period. We will report results from groups of low, full, and high birthweight newborns.

METHOD

Subjects--This study will report the results obtained on a sample of 140 newborn infants born at the Shands Teaching Hospital of the University of Florida, Gainesville. Of these, 52 were from a previous study reported earlier. Seventy-one percent of the subjects were from the Maternal Infant Care population which consists primarily of low socio-economic status Black families. All subjects were clinically normal newborns between 12 hours and 5 days of age at the time of testing. The majority of subjects were between 18 and 36 hours of age. Subjects were born to mothers who had had uneventful pregnancies, with no major delivery

complication, and who had not received more than routine medication during delivery. There were 71 males and 69 females. Subjects were divided into three birthweight groups. The low birthweight group contained 15 males and 24 females between 1000 and 2500 grams. The full birthweight group contained 39 males and 37 females and ranged in birthweight from 2501 to 3900 grams. The high birthweight group ranged from 3901 to 5500 grams and contained 17 males and 8 females. The distribution of social class and obstetric histories were similar in the three groups although there were 20 percent more white newborns in the high than in the full and low birthweight groups.

Procedure--Each subject was observed in the newborn nursery for a period not exceeding three minutes and approximately midway between feedings. Selection for the study was based upon the newborns' state during the observation period. Subjects who were judged to be in a sleep state, as determined by two observers, were selected if they satisfied all other criteria. These criteria included a gestational age greater than 37 weeks, participation of the mother in the Maternal Infant Care program, and the absence of significant birth complications.

A dimly lighted room located approximately 75 feet from the nursery served as our testing room. Room temperature was maintained between 76 and 80 degrees Fahrenheit. Once the subjects had been transported to the testing room, a standard version of the Brazelton Scale was administered (Brazelton, 1973). Following the Brazelton assessment, the records were scored on the 27 behavioral items independently by the examiner and observer. Our scoring reliabilities ranged from .89 to .99 with a mean of .93.

RESULTS

The results of our initial study (N=52) will be reviewed in order that they can be compared with the results from the second larger sample of 140 babies.

Study 1

The first analysis performed on the original sample was a principle components factor analysis with varimax rotation on the 27 x 27 inter-correlation matrix of Brazelton Scale items. Two factors which accounted for more than 10 percent of the variance will be discussed. Table 1 shows the items that defined the two main factors with their associated factor loadings for those items with factor loading above .32. Factor 1 accounted for 20 percent of the variance and was composed of eight items along a dimension of attention-orientation. Factor 2 was composed of seven items along a dimension of temperament-arousal and accounted for 18 percent of the variance. The results of the factor analysis were transformed such that each subject was assigned a summary score based on the raw scores of the items that defined the attention-orientation and temperament-arousal factors. Thus each subject received a composite factor score for Factor 1 and a score for Factor 2.

We then looked at the relation between these summary scores and the eight predictor variables by using a stepwise multiple regression. The linear combination of the eight predictor variables significantly predicted scores on the attention-orientation factor. Birthweight was shown to be the best single predictor of the factor. Lower scores on the attention-orientation factor were associated with lower birthweight babies and infants of younger mothers. Higher scores were found for

females than male babies and white than black infants. The results of the regressions for the temperament-arousal factor showed Apgar scores to be the best single predictor for that factor. Lower Apgar babies scored lower on the temperament-arousal dimension than high Apgar babies.

Study 2

Study 2 was designed to determine the stability and reliability of the factors and to compare the mean scale differences among the different birthweight groups. Study 2 included the entire sample of 140 subjects.

A second principle component factor analysis with varimax rotation for the larger sample was performed on the 27 x 27 intercorrelation matrix of Brazelton items. Eight factors were generated from the factor analysis. Three factors which accounted for at least 10 percent of the variance will be discussed. Table II shows the items that defined the three main factors in study 2, and their associated factor loadings. Factor 1 which we called attention-orientation contained six items and accounted for 31 percent of the variance. Factor 2 accounted for 20 percent of the variance and included five items along a dimension of arousal. Factor 3 was composed of five items along a dimension of temperament and accounted for 13 percent of the variance. Table III lists the items that loaded on the two main factors in Study 1 that were included in Factors 1, 2 and 3 in the second study. Of the original eight items that defined Factor 1 in the first study, five were the items that comprised Factor 1 in the second study. Six of the seven items that defined Factor 2 in the first study were included in Factors 2 and 3 in the second study. We labeled Factor 2 temperament-arousal in Study 1 and this factor seems to have split into two separate factors with the

second larger sample.

The results of the second factor analysis were used in an analysis of variance to examine the relationship between birthweight and the factor scores. To accomplish this we computed a summary score for each subject summing the raw scores for each item that comprised the factor. In other words, each subject received a score for attention-orientation, a score for arousal, and a score for temperament. To test for the effects of birthweight we performed a 3 (birthweight) x 2 (sex) analysis of variance for each summary score with gestational age as the covariate.

The results for the attention-orientation factor showed a significant main effect for birthweight, F (1,109)=3.46, $p < .03$. The mean attention-orientation score for the full birthweight group was higher than the mean score for the low and high birthweight groups. There was significant sex x birthweight interaction for Factor 2, F (2,100)=3.84, $p < .02$. The mean arousal scores were higher for the low birthweight males and high birthweight females than for the other groups. Factor 3 also showed a significant sex x birthweight interaction, F (2,73)=3.80, $p < .03$. This was due to higher temperament scores for low birthweight males and high birthweight females than for the other groups.

DISCUSSION

The results of the second factor analysis in Study 2 are consistent with the factor structure reported in Study 1. The majority of items that defined Factor 1 in the first stucy were also found on the attention-orientation factor in the second study. The second factor, temperament-arousal, in the first study appears to have been redefined as two separate

factors in the second study. These results seem to indicate that the temperament-arousal factor in Study 1 actually represented two distinct but similar dimensions of newborn behavior but possibly because of the small sample size in Study 1, it was not discretely identified. It is also interesting to point out that of the six items which reappeared in Factor 2 and Factor 3 from the original temperament-arousal factor, these items split evenly on both the arousal and temperament factors in the second study. In other words three of the six items loaded on Factor 2 while the other three loaded on Factor 3. The results from Study 1 lend support to the factors previously reported by Scarr and Williams (1971) and those reported in Study 1. Moreover Study 2 demonstrates the stability of the attention-orientation factor as a reliable behavioral dimension to which the Brazelton Scale is sensitive. Study 2 also suggests that other dimension to which the Brazelton Scale is sensitive may have been globally represented in previous studies, (Scarr & Williams; Soule et. al., 1974; Lester et. al., 1976) however because of the limited sample sizes in these studies, a clear delineation of the Brazelton Scale factor structure may have been obscured. With the more appropriate sample size in Study 2 it was possible to identify three separate factors relating to distinct behavioral patterns.

The arousal factor appears to sample the spontaneous accessibility of the newborn to a variety of stimuli. The strength with which the reactions appear may not be independent of the neonate's ability to respond to the immediate environment. Whereas the arousal dimension may reflect the neonate's responsiveness to increasingly aversive stimulation, the

temperament factor may represent a more characteristic style of responding to socially relevant stimuli. This factor seems to parallel the formulations of others, (Thomas, Chess & Birch, 1968; Korner, 1970) regarding temperamental and individual differences in infancy and early childhood.

The significant effects shown for birthweight in the analysis of variance are in support of other studies in which low birthweight infants have been found to exhibit behavioral variations when compared to normal populations (Caputo & Mandell, 1970). Noteworthy also are the effects of birthweight on the attention-orientation factor for the high birthweight group. Not only were these newborns significantly different from normal birthweight newborns, their scores were very similar to those of the low birthweight group. A distinction to be emphasized regarding the high birthweight group is that these neonates, as a group, were not post mature. Studies dealing with birthweight as an independent variable are often subject to criticism since they may fail to control for gestational age (Drillien, 1964). With the covariation due to gestational age controlled, these results become more meaningful. Whereby the postmature newborn who may be of appropriate birthweight often exhibits precocity in its alerting behavior, the high birthweight sample in this study had attentional patterns similar to those newborns of low birthweight status. It could be that the consequences of accelerated intrauterine growth may not, in some respects, be unlike that of retarded fetal growth. Conclusive statements however would constitute a misinterpretation of this data since our high birthweight sample was smaller than the other two groups with a slightly larger distribution of males than females and white than black infants. These cautions hold true also for the interactions between

sex and birthweight on the arousal and temperament factors.

The results of this study although encouraging in regard to delineating some of the influences of birthweight upon newborn behavior, leave many questions unanswered. The Brazelton Scale, with its increasingly widespread and frequent use, may be subject to criticism regarding its established validity and standardization. What for example, would be the behavioral characteristics of a large sample of normal middle class newborns not affected by the variety of influences known to be associated with low socio-economic status? At present the most frequently employed research strategy using the Brazelton Scale has been more or less restricted to selective sampling which may adequately answer the question just raised. These methods which characterize most of the studies referenced in this paper, provide a sensitive but basically descriptive analysis of newborn behavior. They are however vulnerable to limitations of subjective scoring biases.

A potentially more powerful use of the Brazelton Scale would be its application in combination with other measures of behavior, for example autonomic activity such as heartrate. A research design of this type combined with either selective sampling and/or experimental controls would have the advantage of providing reliable and objective data reflecting autonomic nervous system functioning in populations known to be at risk for developmental deficits in addition to providing an overall behavioral assessment of the neonate. Psychophysiological measures correlated with overt behavioral responses obtained in the clinical setting has great promise in furthering our understanding of neonatal and infant behavior as well as those factors by which it is influenced.

TABLE I

Factor Loadings for Items Defining the Attention-Orientation and Arousal-Temperament Factors on the Brazelton Newborn Assessment Scale

Factor 1 Attention-Orientation		Factor 2 Arousal-Temperament	
Item	Loading	Item	Loading
Inanimate visual	.80	Consolability	-.48
Inanimate auditory	.70	Peak of excitement	.92
Animate visual	.70	Rapidity of buildup	.78
Animate auditory	.56	Irritability	.84
Animate visual and auditory	.75	Lability of skin color	.43
Alertness	.76	Lability of state	.49
Muscle Tonus	.49	Self-quieting	-.39

TABLE III

Items from the Brazelton Newborn Assessment Scale which Loaded on Factors in both studies

Factor 1	Factor 2	Factor 3
Item	Item	Item
Inanimate auditory	Inanimate visual	Consolability
Animate visual	Peak of excitement	Lability of states
Animate auditory	Rapidity of Buildup	Self-quieting
Animate visual and auditory	Irritability	
Alertness		

Note: The item "inanimate visual" loaded on Factor 1 in Study I and Factor 2 in Study II.

TABLE II

Factor Loadings for Defining the Attention-Orientation, Arousal, and Temperament Factors on the Brazelton Newborn Assessment Scale

Factor 1 Attention-Orientation		Factor 2 Arousal	
Item	Loading	Item	Loading
Inanimate auditory	.62	Inanimate visual	.43
Animate visual	.78	Peak of excitement	.63
Animate auditory	.58	Rapidity of buildup	.55
Animate visual and auditory	.86	Irritability	.81
Alertness	.86	Activity	.56
Defensive movements	.61		

Factor 3 Temperament	
Item	Loading
Pinprick	.52
Consolability	.64
Startles	.72
Lability of states	.51
Self-quieting	.73

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